MEMS Steppers

Lithography Systems to Meet the Needs of MEMS, LEDs, and More

Key Benefits

- Basic and enhanced systems available to satisfy varied product/budget requirements
- Large depth of focus and shot-by-shot autofocusing maximize yield
- Superior Nikon lens technology enables resolution down to 1 µm
- Accommodate a wide range of substrate sizes, shapes, and flatness
- Flexible, advanced alignment systems enable overlay accuracy ≤ 0.30 µm
- Deliver high productivity on user-friendly stepper platform

Meeting the needs of MEMS, LEDs, and More

Micro Electro Mechanical Systems (MEMS) do not have the same aggressive imaging or overlay requirements demanded by semiconductors. However, they necessitate that lithography systems are able to handle a variety of substrates – including extremely warped wafers and very thick films, and must also accommodate significant step heights. In addition, bulk MEMS applications or Taiko wafers often need precise alignment to marks located on the backside of the wafer surface.

Nikon MEMS Steppers

Nikon MEMS Steppers provide extremely diverse processing capabilities. They have been very successful in meeting customers' unique requirements for not only Air Bearing Surface (ABS) fabrication and MEMS applications, but also for light emitting diodes (LEDs), discretes, and more. MEMS Steppers are also well-suited for patterning Cu Pillar insulating layers as well as the insulating layers used in bumping processes.

Basic and enhanced systems available to satisfy varied product/budget requirements

Nikon continues to focus on expanding MEMS Stepper capabilities to meet varied performance and budgetary objectives for our customers. An expanded MEMS Stepper product line and newly developed systems maximize productivity, support substrates up to 200 mm, and enhance imaging with ghi/i-line capabilities. In addition, a multitude of add-on functions further boost system performance and yield. Well over 150 MEMS Steppers are in use around the world today.

MEMS Steppers

Lithography Systems to Meet the Needs of MEMS, LEDs, and More

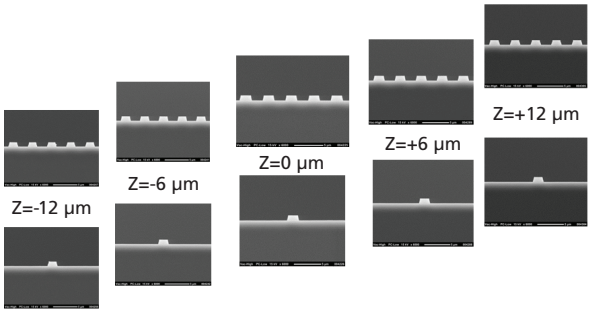
Large depth of focus and shot-by-shot autofocusing maximize yield

MEMS Steppers use low numerical aperture (NA) lens designs specifically optimized for MEMS-type applications, as well as shot-by-shot autofocusing. This combination enables them to deliver the necessary resolution with tremendous depth of focus (DOF).

Depth of Focus NES2W-i06

2.0 µm L/S Lines & Isolated

Resist: PFI-34A t=0.9 µm, 134 mJ/cm², σ=0.65



MEMS Steppers use specially developed low NA lenses to deliver the necessary resolution with tremendous depth of focus.

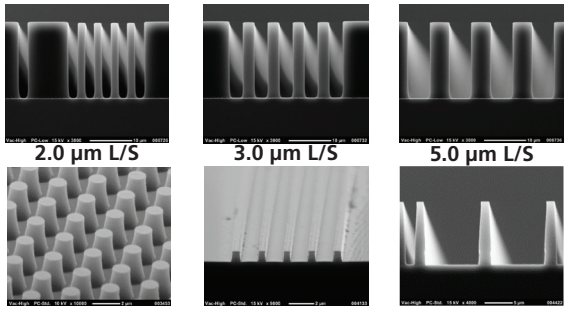
The advanced autofocus (AF) system delivers stable AF performance even using extremely thick resists and transparent substrates. MEMS Steppers now also provide auto leveling capabilities that enable tilt compensation for each shot to maximize DOF for extremely rough surfaces.

Superior Nikon lens technology enables resolution down to 1 µm

MEMS Steppers use proven Nikon IC stepper lens technology that ensures optimal CD uniformity across the wafer. In addition, their projection lens designs eliminate costly mask contamination/defectivity issues experienced with contact or proximity printing methods. The MEMS Stepper product portfolio includes a range of exposure field size/NA/resolution capabilities to meet specific manufacturing requirements. Steppers are available with resolution capabilities down to 1 µm or DOF up to 26 µm.

Excellent Resolution for Thick Resists

NES1W-i06 Resist Thickness t = 18 µm NA: 0.13 σ = 0.5 Focus Offset: +4 µm



1.0 µm PSS by NES1W-h04:
Resist: AZ600 t = 2 µm
NA: 0.16; σ=0.7 Focus Offset: 0 µm

1.0 µm L/S by NES1W-h04A:
Resist: PF134 t = 0.73 µm
NA: 0.20; σ=0.6 Focus Offset: 0 µm

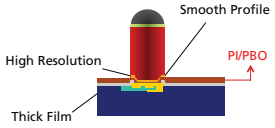
2.0 µm L/S by NES1W-h06:
Resist: TMMR P-W1000T PM t = 10 µm
NA: 0.13; σ=0.65 Focus Offset: 0 µm

Systems provide excellent imaging and accommodate extremely thick resists.

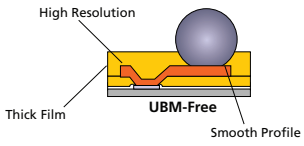
In addition to MEMS and LED litho applications, these specially developed steppers can also be used to pattern Cu Pillar insulating layers as the steppers' large depth of focus contributes to outstanding pillar resolution and sharp profiles. MEMS Steppers' wide DOF capabilities also optimize the insulating layers used in bumping processes to support under-bump metallization-free (UBM-free) wafer level chip scale packaging applications.

Outstanding Imaging for Cu Pillars and WL-CSP

Cu Pillar Requirements

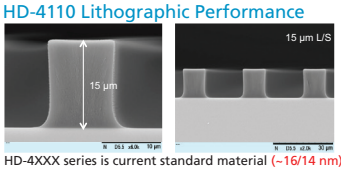


UBM Free WL-CSP Requirements



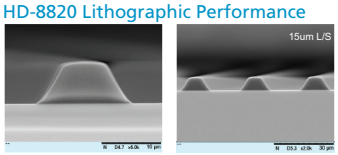
UBM: Under bump metallurgy;
WL-CSP: Wafer level chip scale packaging

HD-4110 Lithographic Performance



HD-4XXX series is current standard material (~16/14 nm)

HD-8820 Lithographic Performance



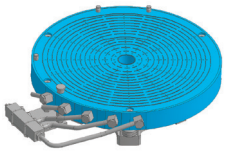
Prepared in cooperation with HDM.

Enable outstanding resolution and smooth profiles for Cu pillars as well as UBM-free WL-CSP.

Accommodate a wide range of substrate sizes, shapes, and flatness

MEMS Steppers accommodate a variety of substrate shapes and materials. Handling capabilities range from 50 to 200 mm, and Nikon is eager to partner with customers to meet other specific requirements. The Zoned Wafer Vacuum System supports warped substrate handling, and MEMS Steppers have demonstrated the capability to compensate for up to 600 µm of substrate warpage.

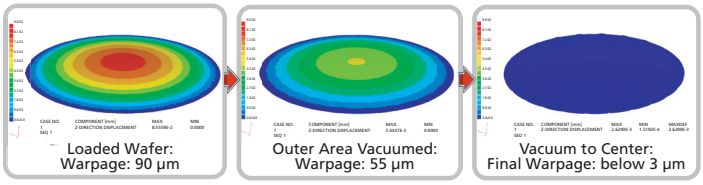
Handle Non-Si and Warped Substrates Effectively



Zoned Vacuum System:

1. Vacuum area contact gradually changed to accommodate warped wafers
2. Surface of the wafer becomes flat

Custom: Possible to simulate optimal vacuum area for specific warpage/hardness.



Example case shown here. Compensation for warpage > 600 µm has been demonstrated.

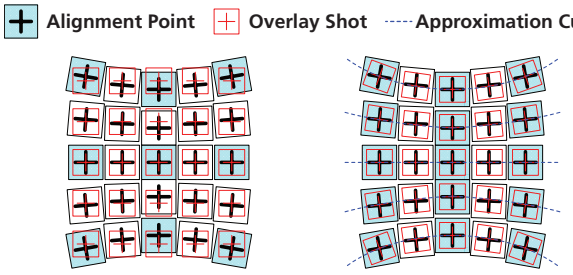
Effectively handle non-silicon and extremely warped substrates.

Flexible, advanced alignment systems enable overlay accuracy ≤ 0.30 µm

Nikon MEMS Steppers provide a high degree of alignment flexibility. They utilize proven Enhanced Global Alignment (EGA) technology with FIA alignment capabilities, which have long been employed on traditional Nikon Step and Repeat equipment, to provide optimal overlay accuracy.

MEMS Steppers support Each Row Alignment (ERA) capabilities as well. ERA can be used to align shot rows separately to further enhance overlay accuracy ≤ 0.30 µm. MEMS Steppers also provide Pattern Matching Alignment capabilities that enable alignment to any uniquely patterned structure, as compared to only specific alignment marks.

Flexible Alignment Systems

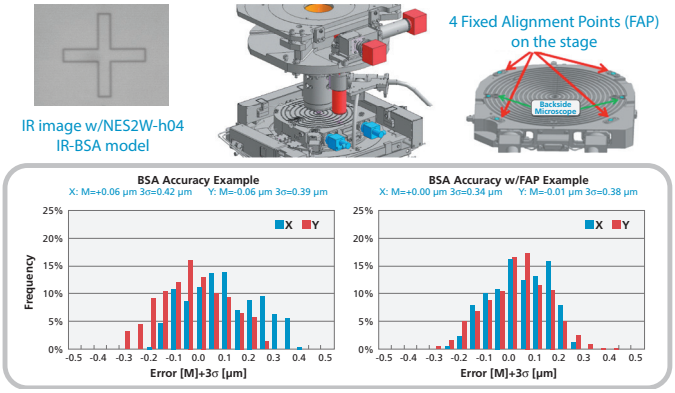


Flexible alignment systems and advanced algorithms optimize overlay accuracy to support performance ≤ 0.30 µm.

The majority of MEMS Steppers also support critical Backside Alignment (BSA) capabilities, and enable BSA accuracy to 0.80 µm and below to satisfy customers' process requirements. The newly developed hybrid backside alignment system uses direct backside alignment (D-BSA) coupled with infrared backside alignment (IR-BSA) to optimize accuracy, and is well suited for power device applications like insulated gate bipolar transistors (IGBT).

Backside alignment performance can be further enhanced to below 0.50 µm with the Fixed Alignment Points (FAP) system. MEMS Steppers enable robust alignment for bonded wafers as well.

Industry-leading D-BSA/IR-BSA Performance



MEMS Steppers provide industry-leading Backside Alignment capabilities that are further enhanced with the FAP system.

Deliver high productivity on user-friendly stepper platform

MEMS Steppers deliver excellent performance capabilities on user-friendly, high productivity stepper platforms. Products support a range of substrate sizes/shapes and flatness, as well as several exposure wavelengths and field sizes to best meet manufacturing goals.

These systems also have small footprints to minimize equipment cost and cleanroom floor space usage. Further, due to their simplified body designs, MEMS Steppers ensure the fastest path to manufacturing.

Nikon continues to expand the MEMS Stepper product line to meet the highly dynamic requirements of these specialized markets for our customers.

					Under Development	
Model	**NES1W-h04**	**NES1W-h04A**	**NES2W-h06**	**NES2W-i06**	**NES1W-i04**	**NES2W-i10**
Resolution (L/S)	1.4 µm	1.1 µm	2.0 µm	1.5 µm	1.0 µm	2.9 µm
Reduction Ratio	1/2.5	1/2.5	1/1.8	1/1.8	1/2.5	1
Lens-NA	0.16	0.20	0.11	0.13	0.20	0.07
Exposure Area	15 mm sq.	15 mm sq.	22 mm sq.	22 mm sq.	15 mm sq.	44 mm sq.
Wavelength	405 nm	405 nm	405 nm	365 nm	365 nm	365 nm
Overlay	0.3 µm	0.3 µm	0.4 µm	0.4 µm	0.3 µm	0.6 µm
Backside Alignment Overlay	0.8 µm	0.8 µm	0.8 µm	0.8 µm	0.8 µm	0.9 µm
Substrate Size	Φ50 mm ~Φ 150 mm	Φ50 mm ~Φ 150 mm	Φ150 mm,Φ 200 mm	Φ150 mm,Φ 200 mm	Φ50 mm ~Φ 150 mm	Φ150 mm,Φ 200 mm
Throughput (100 mJ/cm²)	150 mm: 60 WPH	150 mm: 60 WPH	200 mm: 50 WPH	200 mm: 60 WPH	150 mm: 65 WPH	200 mm: 90 WPH
Dimensions (WxDxH)/ Weight	1,150x1,940 x2,070 mm/ 1,750 kg	1,150x1,940 x2,070 mm/ 1,750 kg	1,440x2,290 x2,100 mm/ 2,150 kg	1,440x2,290 x2,100 mm/ 2,150 kg	1,150x1,940 x2,070 mm/ 1,750 kg	1,440x2,290 x2,100 mm/ 2,150 kg

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Rev. 06/01/2016